What is the History of Science?

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In its quest to understand man's changing perception of the world of nature, History Today asks six further historians, What is the history of science?

John Pickstone

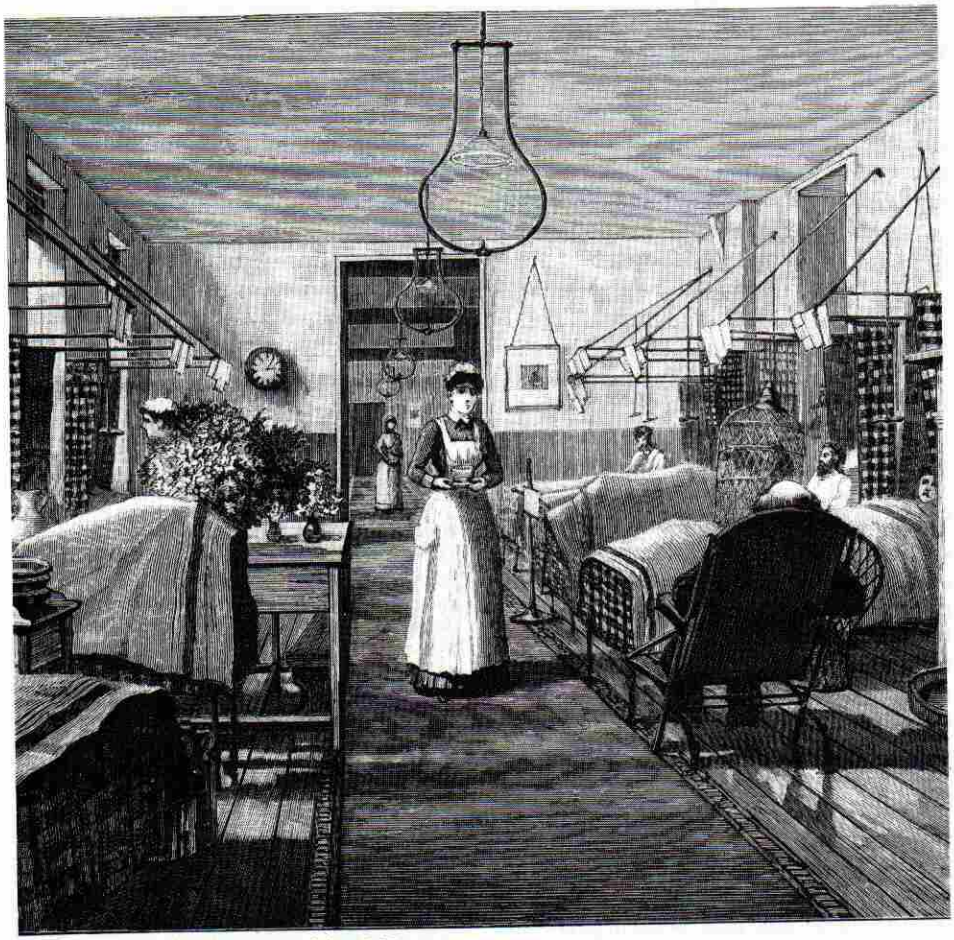
FOR ME AND SEVERAL OF MY generation it has been a progression, from science, to history and philosophy of science, to a broader form of history which includes social as well as intellectual aspects of science. The broader picture is not restricted to knowledge, it includes practice – the crafts of science and especially the practices of technology, agriculture and medicine. Thus we come to deal with a large and central area of social and economic history – the continuing and ever-changing interplay between more or less cumulative knowledge and more or less effective practices.

The 'intellectual' side remains important and stimulating. Popper – Kuhn – Lakatos – Fyerabend have become staples of philosophy of science and are all very much historical. The debates about rationality and shifting frames of reference remain stimulating. Recent French analysis, especially by the late Michel Foucault, has still to be properly explored by Anglo-American historians, though almost twenty years have passed since *The Order of Things* was first published. We still lack criteria for judging the depth and extent of 'structural shifts' in scientific understanding, e.g. around 1800. Shall we continue to explain such shifts as the putative sum of more particular changes linked to patterns of group advancement; or do more general links between social structures and understanding have some purchase here?

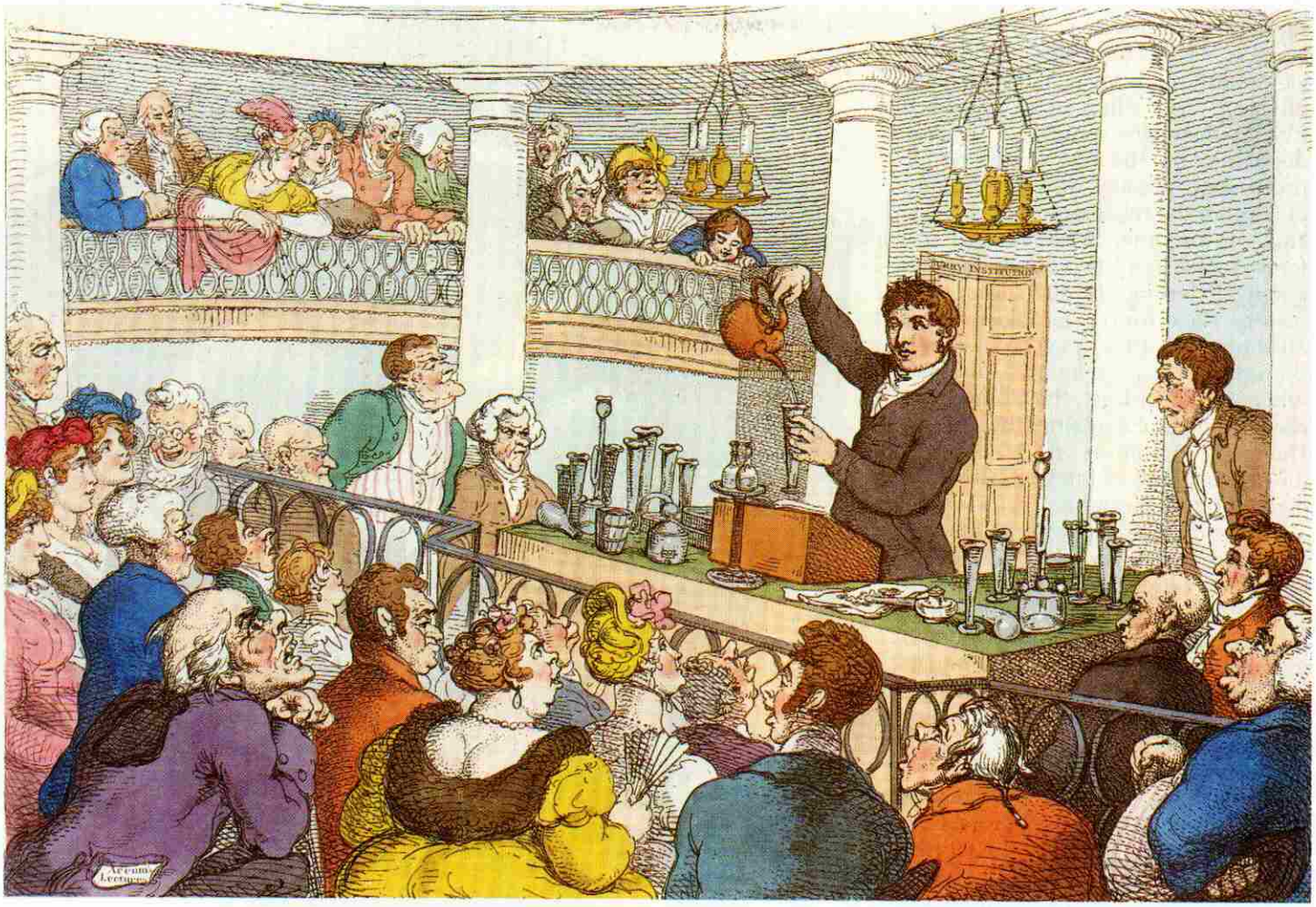
But 'scientific knowledge' is not all, and may often not be primary. Historians of technology and medicine especially, are concerned with patterns of practice that have their own traditions – moulded by social and economic forces, they are as often fields for scientific exploration as for scientific application. The nineteenth-century hospital was a social and professional invention which made a certain kind of medicine possible. As De Solla Price has noted, we need to pay more attention to such *instrumentalities* whether they be largely social, like a hospital; physical, like a telescope; or simply conceptual, like the differential calculus. Such instrumentalities, in many fields, helped create theory though they required little.

So the emphasis shifts to science-practice relations, and to contexts where the social and economic is not mediated only through scientific or religious ideologies – to Pasteur, as well as Darwin, a Pasteur concerned with French economy, not just with problems in scientific method. This kind of approach brings history of science closer to the economic and social history practised in history departments. It also links closely with studies of policy for science, industry and medicine.

Discussion of policy becomes more important as public concern grows and resources do not; practitioners of 'science policy' become more historically-minded as they grow older in such studies. Twenty years ago, history was little more than a gloss in 'social studies of science'; now synthesis is evident; there is opportunity and need for much more. Historians privileged to spend their time in the study of scientific and technical change should welcome engagement in discussions of policy, for all its difficulties. No one concerned with policy in rapidly changing areas can afford the parochialism of a narrow present. Some months



A ward of the London Hospital in 1888.



Chemical lecture by Sir Humphrey Davy at the Surrey Institute; engraving by Thomas Rowlandson, 1810.

ago *The Times* called for a British Institute of Contemporary History. Such enterprises are better conducted in the plural, but whether one or many, such institutes must surely contain specialists in science history. How else can we 'debrief' the influential (or the scientific rank and file); how else can we learn from the archives about critical areas of our present?

Historians of science, technology and medicine straddle major divides in our culture; it is a privileged position, if sometimes an uncomfortable one. They must meet in full the standards of professional historians, but should not lose contact with the students and professionals whose disciplines and occupations they address. Above all they must help provide a framework in which the key issues of technical and social development can be considered by a broad and informed public.

Roy Porter

A GREAT TRANSFORMATION IS UNDER way in how we view the history of science.

When, at the turn of this century, J.B. Bury proclaimed, 'history is a science, no less and no more', he was giving science his vote of confidence. Bury's confidence was widespread. For Victorian minds like his, science was an engine in the intellectual world no less mighty than the steam engine in the industrial. Honest doubters of course voiced their fears (was not science eroding faith and killing poetry?), but science's success in unveiling Nature's laws and transforming material life seemed beyond cavil. As Macaulay sang the praises of Baconian science:

> It has lengthened life, it has mitigated pain, it has extinguished diseases, . . . these are but a part of its fruits and of its first fruits. For it is a philosophy which never rests, which has never attained, which is never perfect. Its law is progress.

Thus to our grandfathers, science was the epitome both of objectivity and utility. It was right that primitive thought-forms like magic were crumbling before science's hard facts and conclusive experiments; good that the humanities themselves were becoming scientific (as Bury thought was happening to history). Not surprisingly then the aim of traditional history of science was clear-cut. It was to trace the march of mind, to show, for instance, how in astronomy Ptolemy had yielded to Copernicus, how in physics Newton had superseded Descartes. For, ultimately, Ptolemy and Descartes had been wrong, Copernicus and Newton right.

This conception of writing the history of science by plotting its progress towards truth has continued to be influential this century, and it has been reinforced by growing acknowledgement of the role played by science in making Western civilisation unique. Thus, as Herbert Butterfield put it, the Scientific Revolution from Copernicus to Newton wrought such changes as to put both the Renaissance and the Reformation in the shade. It remains the creed of popularisers such as Carl Sagan and Isaac Asimov, and is central to Daniel Boorstin's new survey of *The Discoverers*.

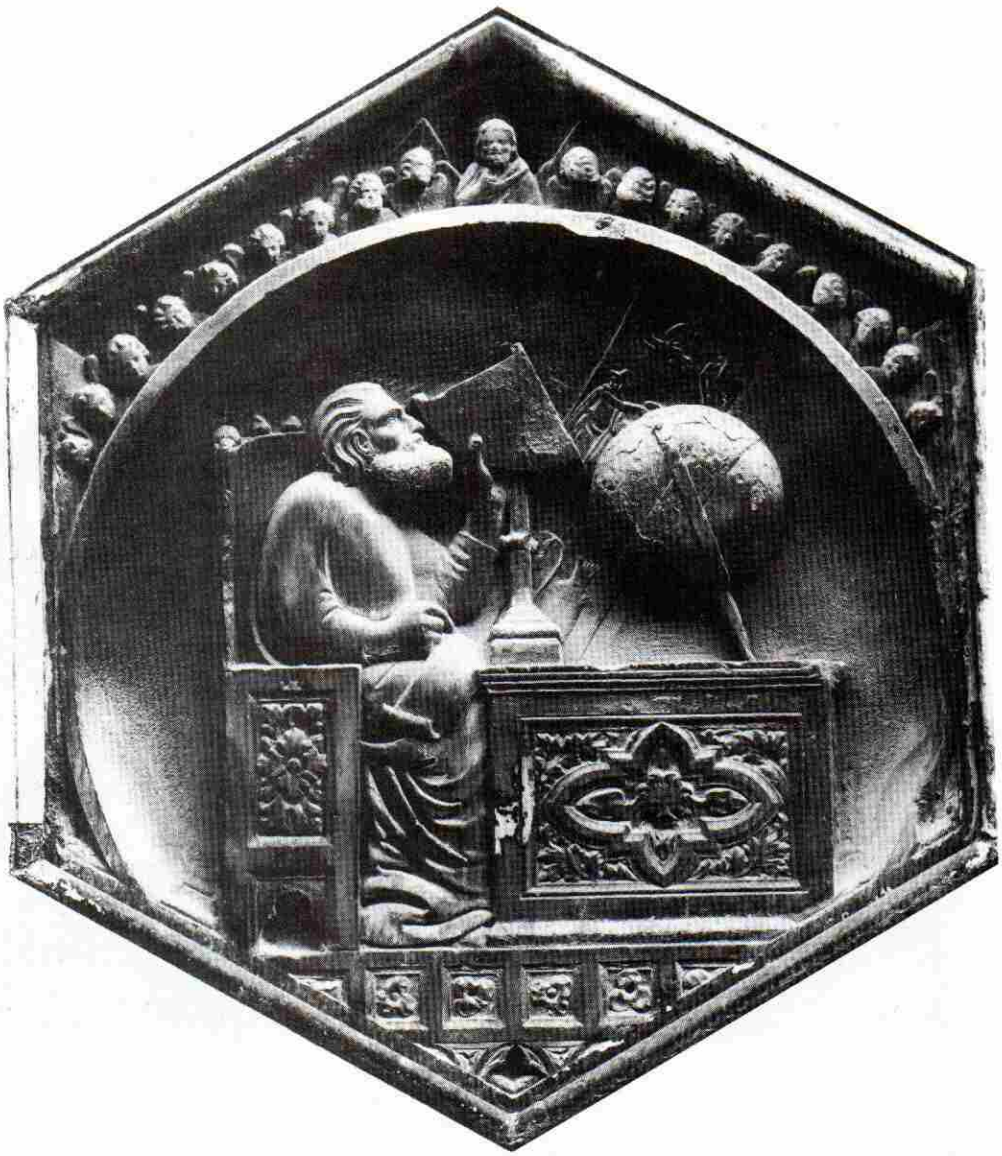
Yet it is being overturned. Revisionist historians of science have reminded us how general history freed itself long ago from religious or political bias, concluding that judging the past by the present produces bad

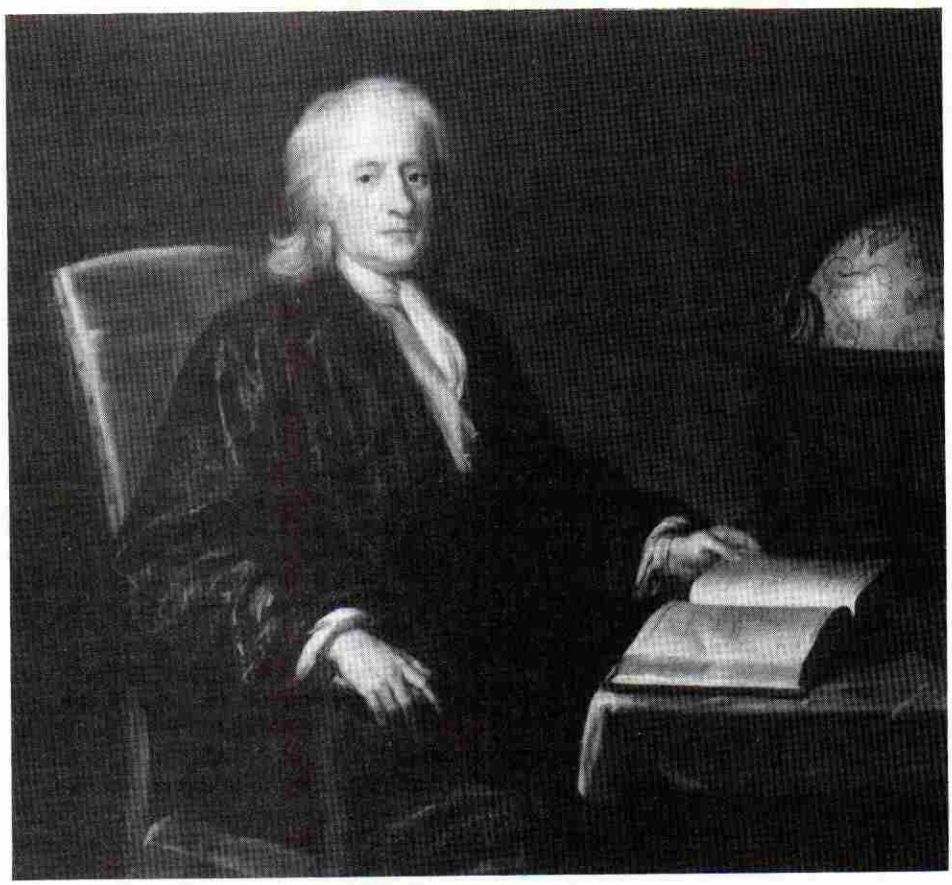
history. But aren't we making the same mistake if we tell the history of science, using hindsight, from the viewpoint of today's astronomy or physics? Too often this approach ('Whig history') paints a canvas depicting, on the one hand, heroic precursors, passing down the baton of truth in the relay race of discovery; and, on the other hand, knaves and fools (such as anti-evolutionists) who got it all wrong. In such Manichee history, the errors of the also-rans get attributed to their psychology and prejudices (e.g. religious dogma), whereas, by contrast, the triumphs of the winners are explained by genius. Theirs are the minds which soar into the stratosphere of intellect, thinking higher, purer thoughts.

But we must reject these 'saints and sinners' caricatures. We shouldn't take sides. Losers need study as much as winners. For example, don't neglect Descartes (as Asimov does) merely because it was the Newtonian not the Cartesian laws of mechanics that ultimately triumphed. For Descartes was a key figure in his own day and immensely influential.

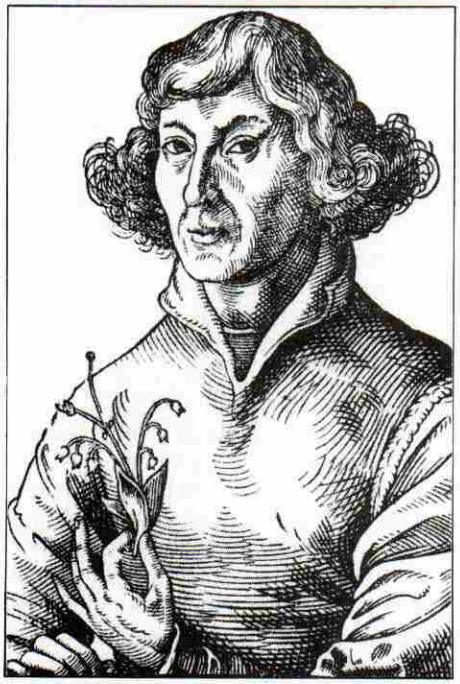
Furthermore, the historian mustn't just stand back and admire genius; he must anatomise the thought-worlds of the 'discoverers'. It begs too many questions to see Newton as 'discovering' the law of gravity merely by dint of the exercise of his towering rationality. Indeed, put his mind under the microscope, and does he even look so rational? For Newton was deeply absorbed in alchemy, in Neo-Platonic philosophy, and in millennialist theology. Nor were these mere hobbies; more likely they were integral to his scientific achievements. Alchemy's doctrine of sympathies probably attuned Newton to the notion of attraction, so vital to universal gravitation; while Neo-Platonism's quest for the immaterial probably persuaded him that the universe was almost entirely pure space, a void. So the inspirations of science turn out to be varied and complex, and include outlooks we'd nowadays see as unscientific.

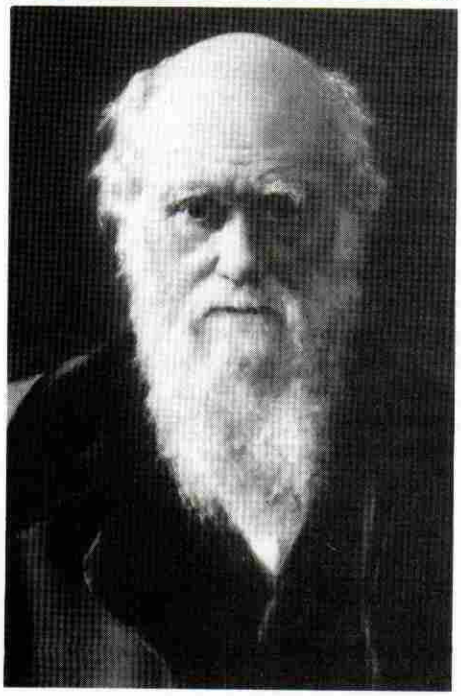
Above all, the new history of science is on its guard against interpreting science's past by present scientific orthodoxy. Take the history of evolutionism. For the last half century the Darwinian theory (evolution works chiefly through natural selection) has been in the driving-seat. So historians





(Above) Ptolemy, astronomer, mathematician and geographer of Alexandria, second century AD.
(Right) Sir Isaac Newton, 1642-1727, author of "Principia" (1687).





have heaped their attentions on Darwin, to the neglect of other evolutionists such as Lamarck. And there have been strenuous efforts to prove that Darwin 'discovered' natural selection 'scientifically', rather than through extraneous stimuli, e.g. after reading Malthus' account of the struggle for survival. But right now biologists are again having grave doubts about the part played by natural selection, stressing instead the role of random variation. Must we therefore start rewriting our histories? That would turn history into a service industry for science itself, which would be akin to intellectual treason.

We live in paradoxical times. Science flourishes as never before. But we are becoming less sure whether it is a blessing or a bane. And, not least, following Einstein and Heisenberg, even the very notion of scientific truth is in the melting pot. In this situation, the job of the historian of science is not to play historiographer royal to science, but to undertake detached analysis of how science really operates, and to examine its place within the wider spheres of thought, culture and society.

Simon Schaffer

ONE OF THE EARLIEST ATTEMPTS to define the scope of the history of science – and, at the same time, to recommend it to a wide popular readership – was that of the radical Dissenter and heroic chemist Joseph Priestley. By 1767, he had completed a lengthy survey of discoveries in the science of electricity made since the earliest times. While his book aimed to cover the whole history of this science, more than one half of the book was needed to deal with the mass of work done in electricity in just the past twenty years. This striking demonstration of cumulative and accelerating progress was Priestley's main concern. It has been the main concern of historians of science ever since. The doyens of twentieth-century history of science, such as George Sarton in the 1930s, made this kind of history the noblest and the most virtuous work any chronicler could perform, just because this was the only activity which the human race had developed which was always progressive, always successful, and increasingly revealing of truth.

(Top) Descartes, 1596-1650; painting by Frans Hals.
(Centre) Copernicus, 1473-1543; a sixteenth-century woodcut.
(Left) Charles Darwin, 1809-82; painting by John Collier.

Priestley put it bluntly: 'civil history', the story of politics and statecraft, 'presents nothing but a tedious uniformity', and any sensitive reader could not 'help being shocked with a view of the vices and miseries of mankind'. By contrast, science itself while virtuous, could not engage our interest because it lacked the human angle. Thus history of science was the best of all forms of history, since it was 'relieved from what is most tedious and disgusting' and at the same time presented 'the human understanding grasping at the noblest objects'. This sales pitch made history of science the best reading matter for an enlightened market.

But in the 1960s something started to go very wrong with this splendid vision. History of science has increasingly turned dirty. 'The vices and miseries of mankind' are now more visible in the stories historians tell about science than almost anywhere else. We were told that Isaac Newton was an autocrat, deeply disturbed by radical critics, Roman Catholicism, and continental operators. Louis Pasteur, cynosure of pure experimenters, suppressed his data, organised campaigns of slander against scientific rivals, and engineered wholescale coups in the polity of nineteenth-century France. More recently, even apparently 'hard' areas of scientific knowledge, such as mathematical statistics, quantum theory, or observational geology, have proved accessible to ingenious historians who have displayed the social interests which sustained claims to truth, and have analysed the cultural wiles which scientists use to make their views stick. Simultaneously, areas of knowledge hitherto quite outside the accepted boundaries of real science, such as phrenology, astrology or mesmerism, have been treated in just the same way as historians treat our own favoured forms of truth. In the conditions of the seventeenth century, the contest between the Society of Astrologers and the critics of judicial astrology is not to be understood as the obvious and inevitable triumph of reason over obscurantism. Historians have become so suspicious of this obviousness that they have begun to avoid using it as an explanatory principle.

The loss of the obvious is probably the most striking aspect of this change in historiography. In Priestley's time, European culture encountered fresh evidence of the enormous cultural diversity of human experience, whether in the South Seas or in the streets of Paris. It is as though this

clash has at last reached the final haven of western European culture – natural science itself. For the principal resources on which the historians of science rely are those developed in the fields of cultural anthropology and comparative sociology. Just as in New Guinea a cassowary is, for some people, not a bird at all, so, in Wiltshire in 1774, the air generated when calcined lead was heated was just not oxygen. It is, of course, quite possible to say that the culture of the New Guinea hill tribes and that of Wiltshire chemists were both mistaken. We know that the cassowary is a bird; we know that calcined lead yields oxygen. But to say as much scarcely allows space for history. The priority has been changed, and the demand is that a space be made where historians can work. It turns out that making that space means getting rid of our obvious assumptions about what is the case in nature. Then historians of science can freely exploit the tools which all other historians have themselves taken for granted. This necessary act of jungle clearance has deep institutional consequences: it brings historians of science closer to other analysts of culture, further from the scientific institutions in which they find themselves. But a more profound understanding of the way science works is a rich reward: it ought to provide science with better means of explaining itself. Priestley agreed:

> These histories are evidently much more necessary in an advanced state of science than in the infancy of it.

Joseph Priestley, 1733-1804. Medallion by Phipson.

Steven Shapin

AMONGST HISTORICAL SPECIALITIES, the history of science has a unique problem. Is it history at all? We take history to be the record of human affairs and actions. Yet the received view of science is that it is founded upon entities which are not man-made: science is based not upon artefacts but upon facts. Scientific matters of fact, along with certain privileged ways of accounting for them (laws, theories), are widely held to be discovered rather than invented. In this received view, we can record the history of discoverers, but that which they discover (objective scientific knowledge) must lie outwith the scope of historical inquiry.

It follows from the received view that science, considered as the corpus of objective knowledge and as an activity governed by a special method, is not a typical form of culture or a typical human pursuit. Thus the history of science is fundamentally different from the history of art, religion, philosophy or politics. Perhaps the history of scientific errors, delusions and by-ways belongs to history proper, but not the history of *science*.

Over the past fifteen or twenty years, this received view of science and its historical study has been systematically challenged. It is now widely, if not universally, maintained that science is a social activity and a form of culture like any other, and that it may be studied and understood accordingly. The challenge has come from three main sources: from the professionalisation of the academic discipline called the history of science and the consequent loosening of its ties to the scientific community as a constituency for its products; from the development of a significant anti-realist and anti-rationalist strand in the philosophy of science; and, perhaps most importantly, from the growth (especially in Britain and on the Continent) of a serious sociology of scientific knowledge, and from increasing contacts between sociologists and historians equally concerned to understand the realities of scientific practice.

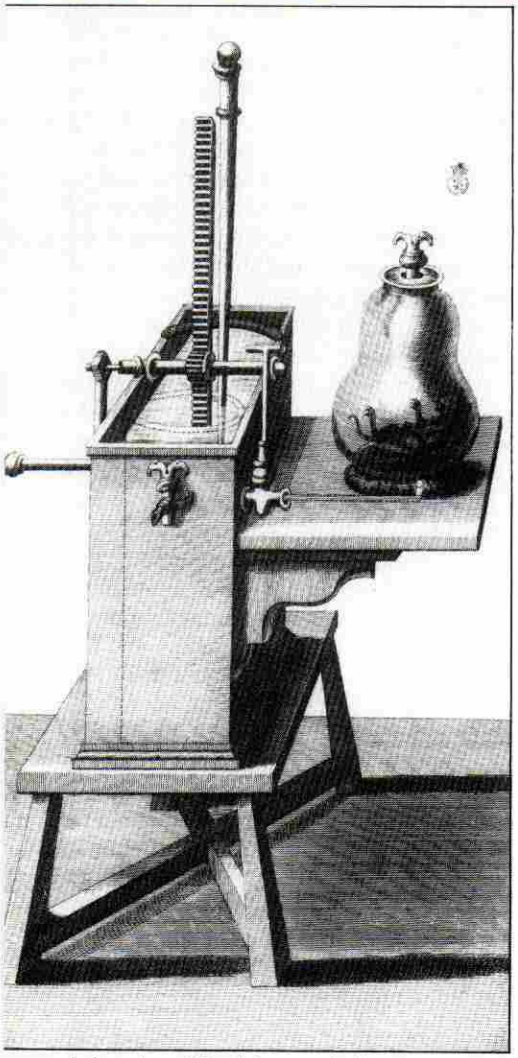
Understanding science as a social activity and as a typical form of culture means that we treat it as goal-directed: we move beyond asking what scientists believe to asking what they are trying to do; it means that we understand beliefs in terms of the inherited and socially-transmitted stock of knowledge available to scientists in their particular settings and in terms of their purposes; it entails understanding the meaning of scientific propositions by referring to their context of use; and it allows us to seek to *explain* scientists' beliefs, whether 'true' or 'false', using the full range of resources available to the historian.

The history of science is a predominantly empirical discipline, and its practitioners have engaged with these projects at a concrete and particular level, generally neglecting the abstract and programmatic arguments of philosophical and sociological theorists. Nevertheless, the body of empirical work which implicitly rejects the received view of science and its history is already impressively large; and existing empirical work has precipitated research programmes of its own. For example, historians have recently shown that in the seventeenth century scientific propositions (including Boyle's and Newton's) were evaluated not only according to their adequacy in technical contexts of use but also according to their value in justifying particular conceptions of God's attributes and the correct moral order of society. Nature was available for such usages because it was conceived to be divine, a theatre for God's activity, a reservoir of moral meaning that might be drawn upon as required to comment upon human conduct.

Suppose it were objected that only past science, pre-professionalised science, can be understood as a typical form of culture. Once, by the end of the nineteenth century, science became properly professionalised, it ceased to be a part of society and a part of the general culture. It would follow that at that moment science ceases to be amenable to truly historical inquiry. The point is an important one for the academic study of science: the sorts of 'social influences' upon science which historians have documented in the seventeenth and eighteenth centuries become much more difficult to trace in the science of modern times. Here is a potential programme for historical research: what were the connections between the professionalisation and differentiation of scientific culture and the development of secular views of nature?

As it happens, modern physical science has been one of the most vigorously worked seams of recent social studies of science. This is where the history of science and the micro-sociology of scientific knowledge approach each other so closely as to be indistinguishable. The goals of present-day high-energy physicists may no longer include comment upon the order of the wider society, but modern science is no less goal-directed, no less socially transmitted, and scientific statements are no less dependent for their meaning upon the context of practical activity.

'The Cow Pock-or-the-wonderful effects of the new innoculation.' Dr Edward Jenner tests his new vaccine with dramatic results. Cartoon by Gillray, June 1802.



A drawing of Boyle's second air-pump experiment to demonstrate the necessity of air to living creatures.

The programme for the history of science is, therefore, to be *history* everywhere in its domain. This programme entails understanding scientific knowledge as the product of human activity. To paraphrase Marx on history:

> Nature does nothing... It is rather man, real living man who does everything.

Robert M. Young

IF SCIENCE IS SO IMPORTANT, WHY is its history so badly served? Most people who read and write history would readily acknowledge tht 'science' – broadly conceived as science, technology and medicine – has been crucial in every era and is at the heart of our own. Yet books and articles about the Protestant and Capitalist Revolutions of the seventeenth century manage to be silent about the Scientific Revolution, even though those three fundamental changes were arguably part of a single set of alterations leading to the modern world and world view. Simlarly, historians of the Victorian era manage to say little about basic changes of view about 'man's place in nature'.

You can look in vain through many standard histories of these periods for serious coverage of the fundamental alterations in theory and practice which were afoot and which had scientific ideas at their centre. In the seventeenth century example, the earth was being displaced from the centre of the universe, and our sun was seen as the centre of our system of planets, while the 'perfect' circles travelled by the planets were being replaced by ellipses. This and other scientific changes, e.g. in the study of physics, were closely interwoven with developments in theology, mining, ballistics and navigation. Yet they get sequestered into specialist books on the history of science and technology. Why should a new view of our world and how we know it be so isolated?

The Victorian example, is, if anything, even odder. If you look at the contemporary periodicals, magazines and novels which were being read by an increasingly literate public, they are full of the topics which historians of our own day tend to ignore when writing Victorian history. Darwin's theory of evolution by natural selection brought humanity into the world of other animals and fundamentally challenged the special status of 'man' and 'mind'. The writings of the time were full of debates on the concepts which were part of Darwinism, just as Darwinism was part of a wider movement of naturalism and secularisation. Natural laws were applied, for example, to human population growth: T.R. Malthus argued that famine, war, pestilence and death were as much the function of scientific laws as the movements of the planets. The history of the earth and of the coming and going of plant and animal species was seen as a natural process, not a result of separate acts of Divine creation and extinction. The mind was increasingly seen as obeying natural laws, based on the functions of the brain, and this challenged traditional ideas of free will and responsibility.

You can find these matters seriously considered in the novels of George Eliot and Benjamin Disraeli and in the Penny Magazines, but not much in our own period's historical works, except those specialising in the history of science.

A similar story could be told about most periods, e.g. ancient, medieval and Renaissance, Chinese, Arab and American histories. In each case science and other branches of expert knowledge tend to be treated in relative isolation from social, political and other parts of intellectual history. The result is that the academic history of science is in most cases seen as a highly specialised field of esoteric knowledge, while the actual history of science was and is important in social and cultural change.

What forces keep it that way? I would say that our education system is doubly daunting in separating off scientific schooling. Pupils stop doing

either science or the arts at an early age and are *taught* to split off scientific knowledge from social, political, economic and cultural knowledge. Arts people end up in awe of science, and scientists end up defensively arrogant about the arts.

In our own time, science, technology and medicine are transforming the conception of babies, education, work, leisure. Think of 'test tube babies', microelectronics, genetic engineering and biotechnology, video, high-technology medicine. If we can't learn to think of science and technology as part of culture in the present, as well as in the past, we will continue to separate them off from debates abut social values and goals. We have paid a high price for making this separation, and are in the process of beginning to pay an even higher one. Politics is the setting of priorities – values and goals in action – to shape social policy. This goal-setting determines what priorities are set in science, what research gets done, what theories, therapies and things are available to us. These play a significant role in determining the new technologies that embody the social forces that shape our lives. This was true in the great era of exploration at the end of the Renaissance; it was true in creating manufacture and machinofacture, mass production and automation.

In thinking about this urgent set of issues, I would say that the historian of science should not be an abstruse specialist. She or he belongs in the mainstream of social and cultural debate. If we can't get science integrated into history, we won't see how our own history is being made, and, more importantly, we won't give the public access to how we decide it should be made.

History of science now sits in an uneasy niche as a cultural ornament to science or as a tiny sub-speciality within history. It needs to be treated by historians as the fundamental part of culture that it has always been in practice.

John Ziman

THE HISTORY OF SCIENCE IS WHAT is made of it by scientists, metascientists, non-scientists and – historians of science. Each of these audiences expects to hear different things about science.

The scientists want a chronicle of the advance of knowledge. They want 'the record put straight' on every 'discovery' that is now thought to be valid. Scientific discoveries are claimed in precisely dated, definitively authored, publicly communicated and systematically archived documents. The job of the historian of science is to sift through the books and journal articles that have accumulated in total scientific libraries and reassure scientists that they will eventually get the credit for their work. Since the formal literature of science is immense, and not as well-ordered as it pretends, this Whiggish project has its rewards. It is just conceivable that the *Proceedings of the Natural Philosophy Society of Obersteindorf* might contain an article, dated December 1904, by Dr. B. Zweistein, in which there occurred the equation $U=WV^2$ (where U stands for energy, W for mass, and V for the velocity of light). Then A. Einstein's paper of 1905 would have been pipped at the post, and Zweistein is the one who should have been given the Nobel Prize for discovering Relativity. What a pity the poor fellow died as he lived, a clerk in the Patent Office of Unterschwabia! At least we can celebrate the centenary of his death, in 2023.

Albert Einstein, 1879-1955, author of "The Meaning of Relativity" (1923).

Scientists commit themselves objectively to the history of science through their individual claims to priority of discovery. But this individualism flows over subjectively into anecdote. In their reminiscences they live again the human delights of their craft, and reflect upon themselves the glory of once having associated with geniuses. 'Did you ever meet Zweistein?' 'Not that I can recall, but, you know, Einstein really didn't wear socks.'

Unfortunately, the anecdotes recorded in autobiographies and obituaries sometimes upset the record. It is not only that it has to be admitted that the late Professor Dreistein was a bit of a *schwein* to his students ('but it was good for us, of course'). Didn't Zweistein get a letter from Einstein, in 1903, answering some little question – or was it the other way round? So there is another history to be written, the *real* chronicle of priorities, where justice will be done to all such informal influences on the advancement of knowledge. For a scientist, the ideal biographer searches letters, laboratory notebooks and accumulated scribbling to maximise its human subject as a progenitor or unacknowledged precursor of all the best scientific ideas of the future.

Metascientific history ignores mere people. A philosopher will want to know whether Zweistein's symbols U, W and V mean quite the same as Einstein's E, M and C: perhaps one should say that, strictly speaking, there were two distinct discovery events, relating to incommensurable theories. A sociologist might investigate the social composition of the membership of the Obersteindorf Natural Philosophy Society, demonstrating its subservience to the proprietor of the local gunpowder factory, thus indicating the true class interest in this pregnant invention. The economic history of science is still in its infancy, but there might be a lesson for contemporary science policy from an estimate of the resources then available to patent officers with a yen for theoretical physics. And so on.

None of these metascientific questions would, of course, be of the slightest interest to scientists or to most non-scientists. Until recently, these two audiences agreed that the history of science should celebrate the achievements of science, and of scientists, in no uncertain terms. The hagiography of science is still not